ABC's of Figuring Interest,The

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Description:

Discusses the various ways of calculating interest and how this can affect the dollar amount paid.

This document may be printed.

ABCs of Figuring Interest

- *How is the interest you pay or receive calculated?*
- *How do these calculations affect your interest?*
- *What's the difference between simple interest and compound interest?*
- *Does repaying a loan early save you money?*

ABCs of Figuring Interest

Although Shakespeare cautioned "neither a borrower nor a lender be," using and providing credit has become a way of life for many individuals in today's economy. Examples of borrowing by individuals are numerous--home mortgages, car loans, credit cards, etc. While perhaps more commonly thought of as investing, many examples of lending by individuals can be identified. By opening a savings account, an individual makes a loan to the bank; by purchasing a savings bond, an individual makes a loan to the government.

As with goods and services that an individual might buy or sell, the use or extension of credit has a price attached to it, namely the interest paid or earned. And, just as consumers shop for the best price on a particular item of merchandise, so too should consumers "comparison shop" for credit--whether borrowing or lending. But comparing prices for credit can, at times, be confusing. Although the price of credit is generally stated as a rate of interest, the amount of interest paid or earned depends on a number of other factors, including the method used to calculate interest.

Two federal laws have been passed to minimize some of the confusion consumers face when they bor-row or lend money. The Truth in Lending Act, passed in 1968, has made it easier for consumers to comparison shop when they borrow money. Similarly, the purpose of the Truth in Savings Act, passed in 1991, is to assist consumers in comparing

deposit accounts offered by depository institutions.

Provisions of the Truth in Lending Act have been implemented through the Federal Reserve's Regulation Z, which defines creditor responsibilities. Most importantly, creditors are required to disclose both the Annual Percentage Rate (APR) and the total dollar Finance Charge to the borrowing consumer. Simply put, the APR is the relative cost of credit expressed in percentage terms on the basis of one year. Just as "unit pricing" gives the consumer a basis for comparing prices of different-sized packages of the same product, the APR enables the consumer to compare the prices of different loans regardless of the amount, maturity, or other terms.

Similarly, provisions of the Truth in Savings Act are to be implemented through the Federal Reserve's Regulation DD, effective March 1993. These provisions include a requirement that depository institutions disclose an annual percentage yield (APY) for interest-bearing deposit accounts. Like the APR, an APY will provide a uniform basis for comparison by indicating, in percentage terms on the basis of one year, how much interest a consumer receives on a deposit account.

While federal laws make it easier to comparison shop for credit and deposit accounts, a variety of meth-ods continue to be used to calculate the amount of interest paid or earned by a consumer. To make an informed decision, it is useful to understand the relationships between these different methods.

Interest Calculations

Interest represents the price borrowers pay to lenders for credit over specified periods of time. The amount of interest paid depends on a number of factors: the dollar amount lent or borrowed, the length of time involved in the transaction, the stated (or nominal) annual rate of interest, the repayment schedule, and the method used to calculate interest.

If, for example, an individual deposits $1,000 for one year in a bank paying 5 percent interest on savings, then at the end of the year the depositor may receive interest of $50, or some other amount, depending on the way interest is calculated. Alternatively, an individual who borrows $1,000 for one year at 5 percent and repays the loan in one payment at the end of a year may pay $50 in interest, or some other amount, again depending on the calculation method used.

Simple interest

The various methods used to calculate interest are basically variations of the simple interest calculation method.

The basic concept underlying simple interest is that interest is paid only on the original amount borrowed for the length of time the borrower has use of the credit. The amount borrowed is referred to as the principal. In the simple interest calculation, interest is computed only on that portion of the original principal still owed.

Example 1

Suppose $1,000 is borrowed at 5 percent and repaid in one payment at the end of one year. Using the simple interest calculation, the interest amount would be 5 percent of $1,000 for one year or $50 since the borrower had use of $1,000 for the entire year.

When more than one payment is made on a sim-ple interest loan, the method of computing interest is referred to as "interest on the declining balance." Since the borrower only pays interest on that amount of original principal that has not yet been repaid, interest paid will be smaller the more frequent the payments. At the same time, of course, the amount of credit at the borrower's disposal is also smaller.

Example 2

Using simple interest on the declining balance to compute interest charges, a 5 percent, $1,000 loan repaid in two payments--one at the end of the first half-year and another at the end of the second half-year--would accumulate total interest charges of $37.50. The first payment would be $500 plus $25 (5 percent of $1,000 for one-half year), or $525; the second payment would be $500 plus $12.50 (5 percent of $500 for one-half year), or $512.50. The total amount paid would be $525 plus $512.50, or $1,037.50. Interest equals the difference between the amount repaid and the amount borrowed, or $37.50. If four quarterly payments of $250 plus interest were made, the interest amount would be $31.25; if 12 monthly payments of $83.33 plus interest were made, the interest amount would be $27.08.

Example 3

When interest on the declining balance method is applied to a 5 percent, $1,000 loan that is to be repaid in two equal payments, payments of $518.83 would be made at the end of the first half-year and at the end of the second half-year. Interest due at the end of the first half-year remains $25; therefore, with the first payment the balance is reduced by $493.83 ($518.83 less $25), leaving the borrower $506.17 to use during the second half-year. The interest for the second half-year is 5 percent of $506.17 for one-half year, or $12.66. The final $518.83 payment, then, covers interest of $12.66 plus the outstanding balance of $506.17. Total interest paid is $25 plus $12.66, or $37.66, slightly more than in Example 2.

This equal payment variation is commonly used with mortgage payment schedules. Each payment over the duration of the loan is split into two parts. Part one is the interest due at the time the payment is made, and part two--the remainder--is applied to the balance or amount still owed. In addition to mortgage lenders, credit unions typically use the simple interest/declining balance calculation method for computing interest on loans. A number of banks also offer personal loans using this method.

Other Calculation Methods

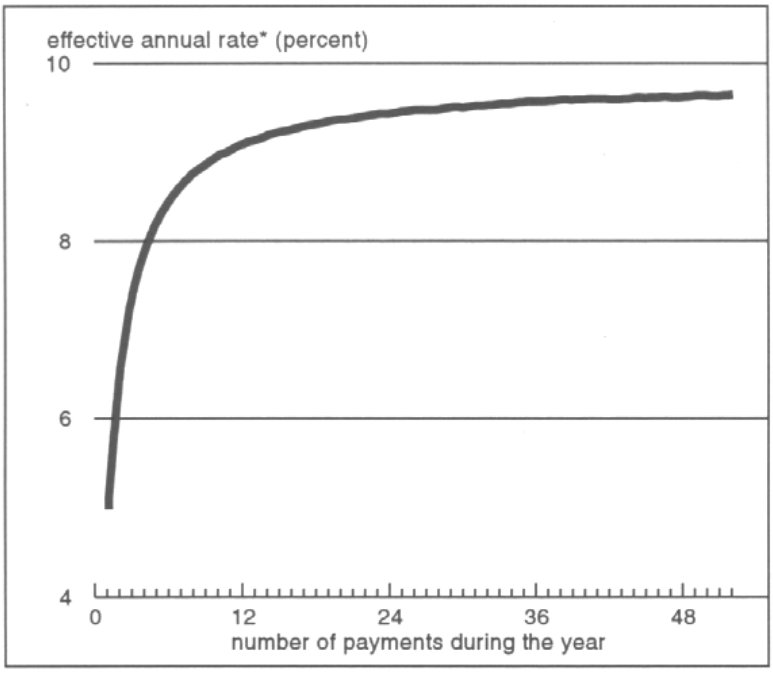
Add-on interest, bank discount, and compound interest calculation methods differ from the simple interest method as to when, how, and on what balance interest is paid. The "effective annual rate" for these methods is that annual rate of interest which, when used in the simple interest rate formula, equals the amount of interest payable in these other calculation methods. For the declining balance method, the effective annual rate of interest is the stated or nominal annual rate of interest. For the methods described below, the effective annual rate of interest differs from the nominal rate.

Add-on interest

When the add-on interest method is used, interest is calculated on the full amount of the original principal. The interest amount is immediately added to the original principal, and payments are determined by dividing principal plus interest by the number of payments to be

Add-on Interest

The more frequent the payments, the higher the effective rate



*Based on 5 percent add-on, one year loan.

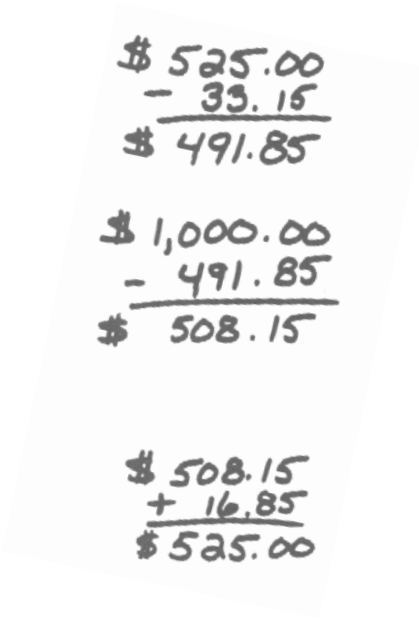
made. When only one payment is involved, this method produces the same effective interest rate as the simple interest method. When two or more payments are to be made, however, use of the add-on interest method results in an effective rate of interest that is greater than the nominal rate. (See chart on page 6.) True, the interest amount is calculated by applying the nominal rate to the total amount borrowed, but the borrower does not have use of the total amount for the entire time period if two or more payments are made.

Example 4

Consider, again, the two-payment loan in Example 3. Using the add-on interest method, interest of $50 (5 percent of $1,000 for one year) is added to the $1,000 borrowed, giving $1,050 to be repaid; half (or $525) at the end of the first half-year and the other half at the end of the second half-year.

Recall that in Example 3, where the declining balance method was used, an effective rate of 5 percent meant two equal payments of $518.83 were to be made. Now with the add-on interest method each payment is $525. The effective rate of this 5 percent add-on rate loan, then, is greater than 5 percent. In fact, the corresponding effective rate is 6.631 percent. This rate takes into account the fact that the borrower does not have use of $1,000 for the entire year, but rather use of $1,000 for the first half-year and use of about $500 for the second half-year.

To see that a one-year, two equal-payment, 5 percent add-on rate loan is equivalent to a one-year, two equal-payment, 6.631 percent declining balance loan, consider the following. When the first $525 payment is made, $33.15 in interest is due (6.631 percent of $1,000 for one-half year). Deducting the $33.15 from $525 leaves $491.85 to be applied to the outstanding balance of $1,000, leaving the borrower with $508.15 to use during the second half-year. The second $525 payment covers $16.85 in interest (6.631 percent of $508.15 for one-half year) and the $508.15 balance due.



In this particular example, using the add-on inter-est method means that no matter how many payments are to be made, the interest will always be $50. As the number of payments increases, the borrower has use of less and less credit over the year. For example, if four quarterly payments of $262.50 are made, the borrower has the use of $1,000 during the first quarter, around $750 during the second quarter, around $500 during the third quarter, and around $250 during the fourth and final quarter. Therefore, as the number of payments increases, the effective rate of interest also increases. For instance, in the current example, if four quarterly payments are made, the effective rate of interest would be 7.922 percent; if 12 monthly pay-ments are made, the effective interest rate would be 9.105 percent. The add-on interest method is some-times used by finance companies and some banks in determining interest on consumer loans.

Bank discount

When the bank discount calculation method is used, interest is calculated on the amount to be paid back, and the borrower receives the difference be- tween the amount to be paid back and the interest amount. The bank discount method is also referred to as the discount basis.

Example 5

Consider the loan in Example 1 where a 5 percent, $1,000 loan is to be repaid at the end of one year. If the bank discount method is used, the interest amount of $50 would be deducted from the $1,000, leaving the borrower with $950 to use over the year. At the end of the year, the borrower pays $1,000. The interest amount of $50 is the same as in Example 1. The bor-rower in Example 1, however, had the use of $1,000 over the year. Thus, the effective rate of interest here would be 5.263 percent--$50 divided by $950--com-pared to an effective rate of 5 percent in Example 1.

$1,000.00
50.00
$950.00

$50 ÷ $950 = .05263
or 5.26%

Forms of borrowing that use the bank discount method often have no intermediate payments. For example, the bank discount method is used for Trea-sury bills sold by the U.S. government and commercial paper issued by businesses. In addition, U.S. savings bonds are sold on a discount basis, i.e., at a price below their face value.

How many days in a year?

In the above examples, a year was assumed to be 365 days long. Historically, in order to simplify interest calculations, lenders and borrowers often as-sumed that each year had twelve 30-day months, re-sulting in a 360-day year. For any given nominal rate of interest, the effective rate of interest will be greater when a 360-day year is used in the interest calculation than when a 365-day year is used.

Example 6

Suppose that a $1,000 loan is discounted at 5 percent and payable in 365 days. This is the situation in Example 5 where, based on a 365-day year, the effective rate of interest was 5.263 percent. If the bank discount calculation assumes a 360-day year, then the length of time is computed to be 365/360 or 1-1/72 years instead of exactly one year; the interest deducted (the discount) equals $50.69 instead of $50; and the effective annual rate of interest is 5.34 percent. Some of the examples cited earlier that use the bank discount method, namely Treasury bills sold by the U.S. government and commercial paper issued by businesses, assume a 360-day year in calculating interest.

Compound interest

When the compound interest calculation is used, interest is calculated on the original principal plus all interest accrued to that point in time. Since interest is paid on interest as well as on the amount borrowed, the effective interest rate is greater than the nominal interest rate. The compound interest rate method is often used by banks and savings institutions in determining interest they pay on savings deposits "loaned" to the institutions by the depositors.

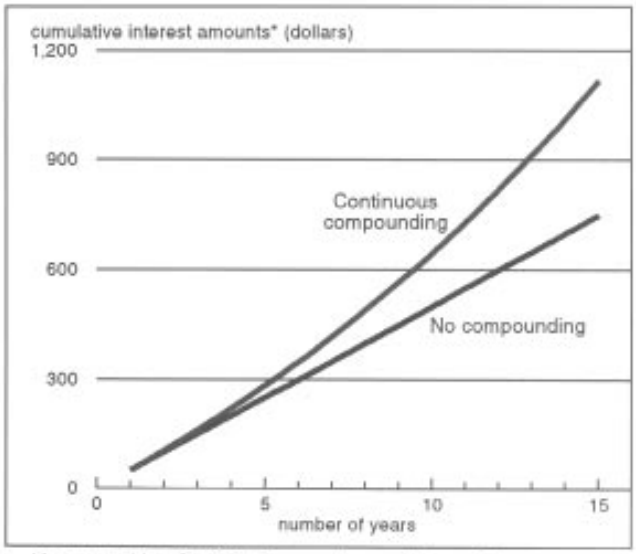
Example 7

Suppose $1,000 is deposited in a bank that pays a 5 percent nominal annual rate of interest, compounded semiannually (twice a year). At the end of the first half-year, $25 in interest (5 percent of $1,000 for one-half year) is payable. At the end of the year, the interest amount is calculated on the $1,000 plus the $25 in interest already paid, so that the second interest payment is $25.63 (5 percent of $1,025 for one-half year). The interest amount payable for the year, then, is $25 plus $25.63, or $50.63. The effective rate of interest is 5.063 percent, which is greater than the nominal 5 percent rate.

The more often interest is compounded within a particular time period, the greater will be the effective rate of interest. In a year, a 5 percent nominal annual rate of interest compounded four times (quarterly) re-sults in an effective annual rate of 5.0945 percent; com-pounded 12 times (monthly), 5.1162 percent; and com-pounded 365 times (daily), 5.1267 percent. When the interval of time between compoundings approaches zero (even shorter than a second), then the method is known as continuous compounding. Five percent continuously com-pounded for one year will result in an effective annual rate of 5.1271 percent. (See chart below.)

Compound Interest

Over time, compounding increases the amount of interest paid



*Amount paid on $1,000 at 5 percent annual interest rate.

When Repayment Is Early

In the above examples, it was assumed that peri-odic loan payments were always made exactly when due. Often, however, a loan may be completely repaid before it is due. When the declining balance method for calculating interest is used, the borrower is not penalized for prepayment since interest is paid only on the balance outstanding for the length of time that amount is owned. When the add-on interest calculation is used, however, prepayment implies that the lender obtains some interest that is unearned. The borrower then is actually paying an even higher effective rate since the funds are not available for the length of time of the original loan contract.

Some loan contracts make provisions for an interest rebate if the loan is prepaid. One method used in determining the amount of the interest rebate is referred to as the "Rule of 78." Application of the Rule of 78 yields the percentage of the total interest amount that is to be returned to the borrower in the event of prepayment. The percentage figure is arrived at by dividing the sum of the integer numbers (digits) from one to the number of payments remaining by the sum of the digits from one to the total number of payments specified in the original loan contract. For example, if a five-month loan is paid off by the end of the second month (i.e., there are three payments remaining), the percentage of the interest that the lender would rebate is (1+2+3)/(1+2+3+4+5) = (6/15), or 40 percent. The name derives from the fact that 78 is the sum of the digits from one to 12 and, therefore, is the denominator in calculating interest rebate percentages for all 12-period loans.

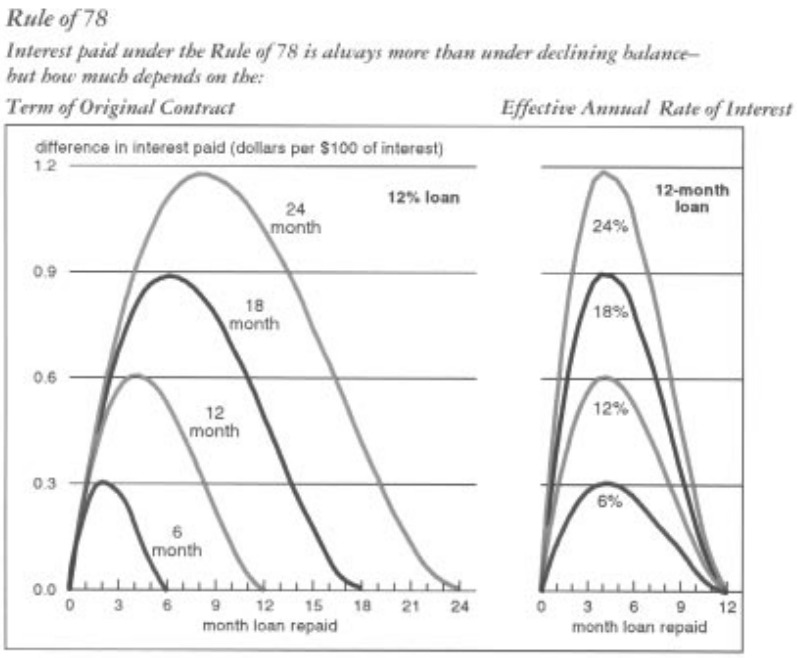
Application of the Rule of 78 results in the borrowers paying somewhat more interest than would have been paid with a comparable declining balance loan. How much more depends on the total number of payments specified in the original loan contract and the effective rate of interest charged. The greater the specified total number of payments and the higher the effective rate of interest charged, the more the amount of

interest figured under the Rule of 78 exceeds that under the declining balance method.

The difference between the Rule of 78 interest and the declining balance interest also varies depending upon when the prepayment occurs. This difference over the term of the loan tends to increase up to about the one-third point of the term and then decrease after this point. For example, with a 12-month term, the dif-ference with prepayment occurring in the second month would be greater than the difference that would occur with prepayment in the first month; the third-month dif-ference would be greater than the second-month differ-ence; the fourth month (being the one-third point) would be greater than both the third month-difference and the fifth-month difference. After the fifth month, each succeeding month's difference would be less than the previous month's difference.

Example 8

Suppose that there are two $1,000 loans that are to be repaid over 12 months. Interest on the first loan is calculated using a 5 percent add-on method, which results in equal pay-ments of $87.50 due at the end of each month ($1,000 plus $50 interest divided by 12 months). The effective annual rate of interest for this loan is 9.105 percent. Any interest rebate due



because of prepayment is to be determined by the Rule of 78.

Interest on the second loan is calculated using a declining balance method where the annual rate of interest is the effective annual rate of interest from the first loan, or 9.105 percent. Equal payments of $87.50 are also due at the end of each month for the second loan.

Suppose that repayment on both loans occurs after one-sixth of the term of the loan has passed, i.e., at the end of the second month, with the regular first month's payment being made for both loans. The interest paid on the first loan will be $14.74, while the interest paid on the second loan will be $14.57, a difference of 17 cents. If the prepayment occurs at the one-third point, i.e., at the end of the fourth month (regular payments having been made at the end of the first, second, and third months), interest of $26.92 is paid on the first loan and interest of $26.69 on the second loan, a difference of 23 cents. If the prepayment occurs later, say at the three-fourths point, i.e., at the end of the ninth month (regular payments having been made at the end of the first through eighth months), $46.16 in interest is paid on the first loan and $46.07 in interest is paid on the second loan, a difference of but 9 cents.

Charges Other than Interest

In addition to the interest that must be paid, loan agreements often will include other provisions which must be satisfied. Two examples of these provisions are mortgage points and required (compensating) deposit balances.

Mortgage points

Mortgage lenders will sometimes require the borrower to pay a charge in addition to the interest. This extra charge is calculated as a percentage of the mortgage amount and is referred to as mortgage points. For example, if 2 points are charged on a $100,000 mortgage, then 2 percent of $100,000, or $2,000, must be paid in addition to the stated interest. The

borrower, therefore, is paying a higher price than if points were not charged--i.e., the effective rate of interest is increased. In order to determine what the effective rate of interest is when points are charged, it is necessary to deduct the dollar amount resulting from the point calculation from the mortgage amount and add it to the interest amount to be paid. The borrower is viewed as having use of the mortgage amount less the point charge amount rather than the entire mortgage amount.

Example 9

Suppose that 2 points are charged on a 20-year, $100,000 mortgage where the rate of interest (declin-ing balance calculation) is 7 percent. The payments are to be $775.30 per month. Once the borrower pays the $2,000 point charge, there is $98,000 to use. With payments of $775.30 a month over 20 years, the result of the 2-point charge is an effective rate of 7.262 percent.

The longer the time period of the mortgage, the lower will be the effective rate of interest when points are charged because the point charge is spread out over more payments. In the above example, if the mortgage had been for 30 years instead of 20 years, the effective rate of interest would have been 7.201 percent.

Required (compensating) deposit balances

A bank may require that a borrower maintain a certain percentage of the loan amount on deposit as a condition for obtaining the loan. The borrower, then, does not have the use of the entire loan amount but rather the use of the loan amount less the amount that must be kept on deposit. The effective rate of interest is greater than it would be if no compensating deposit balance were required.

Example 10

Suppose that $1,000 is borrowed at 5 percent from a bank to be paid back at the end of one year. Suppose, further, that the lending bank requires that 10 percent of the loan amount be kept on deposit. The borrower, therefore, has the use of only $900 ($1,000 less 10 percent) on which an interest mount of $50 (5 percent of $1,000 for one year) is charged. The effective rate of interest is, therefore, 5.556 per-cent as opposed to 5 percent when no compensating balance is required.

Summary

Although not an exhaustive list, the methods of calculating interest described here are some of the more common methods in use. They indicate that the method of interest calculation can substantially affect the amount of interest paid, and that savers and bor-rowers should be aware not only of nominal interest rates but also of how nominal rates are used in calculating total interest charges.

Through time, the level of interest rates may fluctuate, but the methods of calculation remain constant. Thus, the concepts of figuring interest explained in this pamphlet apply regardless of whether the specific numerical examples used are representative of today's market rates.

Further information on the factors determining interest rates is contained in the publication, *Points of Interest.* This pamphlet, as well as other Federal Reserve materials on money and banking, the financial system, the economy, consumer credit, and related topics, are available by contacting:

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January 1979, 5m
January 1980, 20m
April 1981, 30m
December 1983, 12m
November 1984, 15m
October 1985, 20m
December 1986, 40m
September 1992, 15m
September 1993, 7m